

Park, Donghyun; Estrada, Gemma

**Working Paper**

## Are Developing Asia's Foreign Exchange Reserves Excessive? An Empirical Examination

ADB Economics Working Paper Series, No. 170

**Provided in Cooperation with:**

Asian Development Bank (ADB), Manila

*Suggested Citation:* Park, Donghyun; Estrada, Gemma (2009) : Are Developing Asia's Foreign Exchange Reserves Excessive? An Empirical Examination, ADB Economics Working Paper Series, No. 170, Asian Development Bank (ADB), Manila, <https://hdl.handle.net/11540/1823>

This Version is available at:

<https://hdl.handle.net/10419/109370>

**Standard-Nutzungsbedingungen:**

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

**Terms of use:**

*Documents in EconStor may be saved and copied for your personal and scholarly purposes.*

*You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.*

*If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.*



<http://creativecommons.org/licenses/by/3.0/igo>

## ADB Economics Working Paper Series



### Are Developing Asia's Foreign Exchange Reserves Excessive? An Empirical Examination

---

Donghyun Park and Gemma B. Estrada  
No. 170 | August 2009





**ADB Economics Working Paper Series No. 170**

# **Are Developing Asia's Foreign Exchange Reserves Excessive? An Empirical Examination**

**Donghyun Park and Gemma B. Estrada**

August 2009

Donghyun Park is Senior Economist and Gemma Esther B. Estrada is Economics Officer in the Economics and Research Department, Asian Development Bank. The authors thank Hali Edison of the International Monetary Fund for generously sharing her data and empirical model. An earlier version of this paper was presented at the 11th International Convention of the East Asian Economic Association (EAEA) held 15–16 November 2008 in Manila. The authors would like to thank the discussant and participants who provided many useful comments, which were incorporated in revising the paper.

**Asian Development Bank**

Asian Development Bank  
6 ADB Avenue, Mandaluyong City  
1550 Metro Manila, Philippines  
[www.adb.org/economics](http://www.adb.org/economics)

©2009 by Asian Development Bank  
August 2009  
ISSN 1655-5252  
Publication Stock No. WPS090821

The views expressed in this paper  
are those of the author(s) and do not  
necessarily reflect the views or policies  
of the Asian Development Bank.

The ADB Economics Working Paper Series is a forum for stimulating discussion and eliciting feedback on ongoing and recently completed research and policy studies undertaken by the Asian Development Bank (ADB) staff, consultants, or resource persons. The series deals with key economic and development problems, particularly those facing the Asia and Pacific region; as well as conceptual, analytical, or methodological issues relating to project/program economic analysis, and statistical data and measurement. The series aims to enhance the knowledge on Asia's development and policy challenges; strengthen analytical rigor and quality of ADB's country partnership strategies, and its subregional and country operations; and improve the quality and availability of statistical data and development indicators for monitoring development effectiveness.

The ADB Economics Working Paper Series is a quick-disseminating, informal publication whose titles could subsequently be revised for publication as articles in professional journals or chapters in books. The series is maintained by the Economics and Research Department.

## **Contents**

Abstract	v
I. Introduction	1
II. Stylized Facts of Developing Asia's Reserve Build-Up and the Concept of Excess Reserves	2
A. Stylized Facts of Developing Asia's Reserve Accumulation	3
B. The Concepts of Optimal Reserves and Excess Reserves	5
III. Are Developing Asia's Reserves Excessive? An Informal Examination	7
IV. Are Developing Asia's Reserves Excessive? An Econometric Examination	10
V. Concluding Observations	16
References	18



## **Abstract**

Developing Asian countries have accumulated foreign exchange reserves on an unprecedented scale in recent years. There is a growing consensus that Asia's reserves now substantially exceed the levels required for precautionary purposes or for self-protection against currency crisis. The central objective of our paper is to informally and formally test whether reserves in developing Asia have in fact reached excessive levels. Informal tests of reserve adequacy based on widely used rules of thumb such as the Greenspan-Guidotti rule unambiguously indicate the presence of sizable excess reserves. To test for excess reserves more formally, we use panel-data econometric analysis based on Edison (2003). Our estimation results indicate the presence of large and growing excess reserves since 2002. The results of both informal and formal tests thus confirm the popular belief that developing Asia now has excessive foreign exchange reserves. Therefore, the short-run policy challenge for Asian governments is to manage the region's burgeoning excess reserves more actively and use them more productively. One promising area of future research, brought to the fore by the global financial crisis, is to develop more nuanced measures of reserve adequacy that take into account the possibility of severe negative shocks.





## I. Introduction

Since the Asian financial crisis of 1997–1998, there has been an explosive growth in the foreign exchange reserves (henceforth forex reserves) held by the central banks of developing Asia. A large and persistent current account surplus, sometimes reinforced by significant capital inflows, is fueling the build-up of reserves throughout the region. Developing Asia as a region is selling more goods and services to the rest of the world than it is buying from the rest of the world. The resulting net inflow of foreign exchange has far exceeded the region's net purchases of assets from the rest of the world, leading to an ever larger stockpile of forex reserves at the region's central banks. As of September 2008, no fewer than six Asian developing economies were among the world's ten largest holders of forex reserves—People's Republic of China (PRC); Hong Kong, China; India; Republic of Korea; Singapore; and Taipei, China. Furthermore, Indonesia, Kazakhstan, Philippines, Thailand, and Viet Nam also have large and growing amounts of forex reserves.

Many observers outside developing Asia view the region's surging forex reserves as definitive evidence of the region's overreliance on a mercantilist export-led growth model. The underlying idea is that Asian central banks purchase foreign exchange to keep their currencies weak and thus promote exports. Although exports have historically been a key driver of growth in developing Asia, this mercantilist argument is not entirely convincing. For one, the region's reserve build-up has continued unabated despite the appreciation of many regional currencies. A more convincing explanation for the rapid growth of the region's reserves is the precautionary or self-insurance argument. The underlying idea here is that a large war chest of forex reserves serves to protect the economy against sudden shortages of international liquidity and thus helps to prevent currency crises of the kind that devastated Asia in 1997–1998. A further impetus for accumulating reserves as a form of self-insurance is widespread Asian distrust of the International Monetary Fund in the aftermath of the Asian crisis. In light of the severe contraction of output and widespread suffering during the crisis, Asian countries' desire for an ample war chest of international liquidity is more than understandable.

Nevertheless, there is a growing consensus that the reserve levels of many Asian countries now far exceed all plausible estimates of what they need for liquidity purposes. Put differently, the reserve levels may now be substantially above optimal levels. Holding reserves provides benefits, in particular protection against unexpected shortages of foreign exchange and currency crisis, but also entails a number of substantial costs. However, excess reserves are welfare-reducing since the cost of holding an additional

dollar of such reserves is, by definition, larger than the benefit. The larger the excess reserves, the larger will be the loss of national welfare. Therefore, the gap between actual reserves and optimal reserves is more than a passing interest. The first-best solution to the problem of too much reserves is to reduce reserves, although this requires long-term structural adjustments. More immediately, it makes little sense to invest excess reserves in safe and liquid but low-return traditional reserve assets such as United States (US) government securities. Instead excess reserves should be managed more actively to maximize risk-adjusted returns.

The central objective of this paper is to empirically investigate the issue of whether developing Asia does in fact have large and growing excess reserves. The notion of Asian excess reserves has gained such a widespread following that it has almost become conventional wisdom. However, it would be interesting and worthwhile to empirically test the conventional wisdom in light of the substantial policy implications that follow from it. In this paper, we test for the presence of excess reserves in Asia both informally and more formally. At an informal level, there are some widely used rules of thumb that measure the adequacy of reserves. Those rules are based on general economic intuition rather than derived rigorously from formal theory. The difference between actual reserves and adequate reserves can be interpreted as the size of excess reserves. At a more formal level, a number of economic fundamentals can help to explain the level of reserves. For example, we can expect countries with fixed exchange rates to have a higher demand for reserves than countries with flexible exchange rates. It is possible to think of the difference between actual reserve levels and the reserve levels that can be explained by the fundamentals as a measure of excess reserves.

The rest of this paper is organized as follows. Section II looks at the stylized facts of developing Asia's foreign exchange reserve build-up and explains the concept of excess reserves. Section III examines the issue of whether the reserve build-up has led to excessive reserves by applying well-known informal rules of thumb such as the Guidotti-Greenspan rule. Section IV explores the same issue more formally through a simple econometric model that explains reserve levels through a number of variables theoretically influencing the demand for reserves. Section V concludes the paper by discussing the main findings and the policy implications from those findings.

## **II. Stylized Facts of Developing Asia's Reserve Build-Up and the Concept of Excess Reserves**

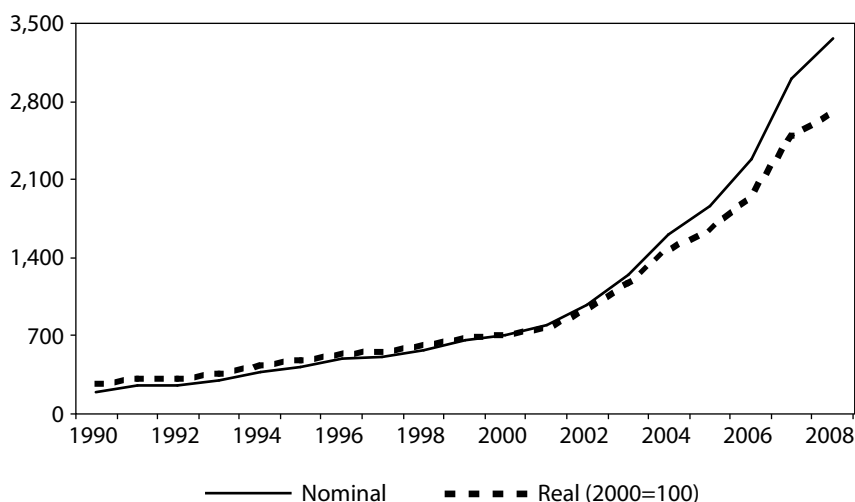
In the first subsection, we examine the stylized facts about the region's forex reserve accumulation since 1990. While the rapid growth of the region's reserves has been a highly topical issue for both policymakers and the general public, a look at the actual data

will give us a more precise idea of how fast the reserves have actually grown and how large they have become. In the second subsection, the vague but popular notion that Asia has “too much” reserves is given greater conceptual concreteness and precision. The concept of excess reserves follows from the concept of optimal reserves, which, in turn, reflects the fact that countries not only obtain benefits from holding reserves but also incur costs.

## A. Stylized Facts of Developing Asia's Reserve Accumulation

Figure 1 below shows the growth in the total forex reserves of developing Asia between 1990 and 2008 in both nominal and real terms. During this period as a whole, developing Asia's reserves rose from US\$202 billion to US\$3,371 billion in nominal terms and from US\$267 billion to US\$2,697 billion in inflation-adjusted terms. During the earlier subperiod of 1990–2000, the region's reserves rose from US\$202 billion to US\$710 billion in nominal terms and from US\$267 to US\$710 billion in real terms. During the more recent subperiod of 2000–2008, the growth of regional reserves has further accelerated, rising from US\$710 billion to US\$3,371 billion in nominal terms and from US\$710 billion to US\$2,697 billion in real terms. In nominal terms, the average annual growth rate of the reserves was therefore 16.9%, 13.4%, and 21.5% for 1990–2008, 1990–2000, and 2000–2008, respectively. In real terms, the average annual growth rate was 13.7%, 10.3%, and 18.2% during the same periods. The overall picture is one of secular growth in developing Asia's reserves since 1990, punctuated by a noticeable acceleration of growth since 2000.

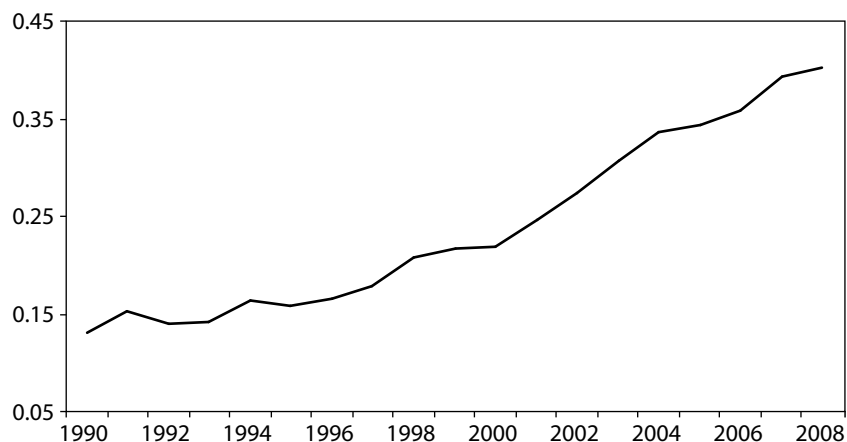
**Figure 1: Nominal and Real Foreign Exchange Reserves of Developing Asia, 1990–2008 (billion US\$)**



Sources: Author's estimates based on data from CEIC Data Company Ltd. and International Monetary Fund, International Financial Statistics online database, both downloaded 15 June 2009.

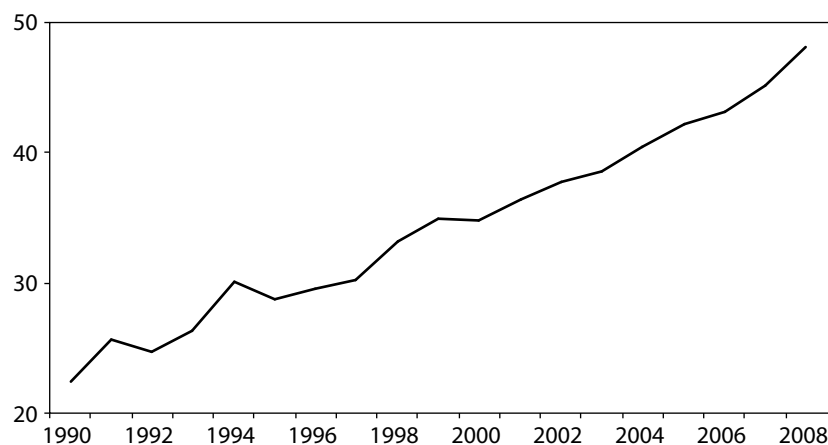
To some extent, the growth of reserves in absolute terms over time simply mirrors the growth of developing Asia's output over time. Therefore, to put the region's reserve build-up in better perspective, we scale its reserves by its GDP. Figure 2 shows the amount of forex reserves relative to GDP. The reserves–GDP ratio shows a similar pattern as the amount of reserves; an uninterrupted increase. Developing Asia's reserves–GDP ratio rose from 13.1% in 1990 to 21.9% in 2000 and further to 40.2% in 2008.

**Figure 2: Ratio of Foreign Exchange Reserves to GDP, Developing Asia, 1990–2008**



Sources: Author's estimates based on data from CEIC Data Company Ltd. and International Monetary Fund, International Financial Statistics online database, both downloaded 15 June 2009.

In assessing the growth in the region's reserves, yet another measure worth looking at is the share of the region's reserves in global reserves. A tangible rise in the region's share would lend further credibility to the global significance of developing Asia's reserve build-up. Figure 3 shows that the region's share of global reserves rose from 22.4% in 1990 to 34.7% in 2000 and 48.1% in 2008. This suggests that developing Asia has indeed been accumulating reserves at a relatively fast pace, in fact more than twice as fast as the rest of the world. It should be noted, however, that the region's reserve accumulation is an integral part of a broader trend of accelerated reserve accumulation by developing countries, whose share of global reserves has risen from 27.7% to 64.8% in 2008. The PRC accounts for more than 50% of the total regional reserve growth between 1990 and 2008. Therefore, the contribution of the PRC to the reserve build-up is notable but, at the same time, the build-up is a regionwide phenomenon. Table 1 lists the region's top 10 reserve holders as of the end of 2008.

**Figure 3: Developing Asia's Share of World Reserves, 1990–2008 (percent)**

Sources: Author's estimates based on data from CEIC Data Company Ltd.; International Monetary Fund, International Financial Statistics online database and Currency Composition of Official Foreign Exchange Reserves, available: [www.imf.org/external/np/sta/cofer/eng/index.htm](http://www.imf.org/external/np/sta/cofer/eng/index.htm), all downloaded 15 June 2009.

**Table 1: Developing Asia's Top 10 Reserve Holders, 31 December 2008**

Rank	Economy	Stock of Foreign Exchange Reserves (billion US\$)
1	China, Peoples Rep. of	1,946
2	Taipei, China	292
3	India	247
4	Korea, Rep. of	200
5	Hong Kong, China	182
6	Singapore	174
7	Thailand	108
8	Malaysia	91
9	Indonesia	49
10	Philippines	33

Sources: CEIC Data Company Ltd.; International Monetary Fund, International Financial Statistics online database, both downloaded 15 June 2009.

## B. The Concepts of Optimal Reserves and Excess Reserves

The notion of excess reserves is linked with the concept of optimal reserve levels, which, in turn, is associated with the benefits and costs of reserves. Reserves provide two main benefits: (i) self-insurance against financial crisis and (ii) mercantilist export promotion. It is difficult to exaggerate the traumatic impact of the Asian crisis, the immediate cause of which was a shortage of international liquidity, on the Asian psyche. Building up large war chests of international liquidity to insure oneself against Asian crisis-type financial turmoil is known as the self-insurance or precautionary demand for reserves. The other main benefit of reserves pertains to the mercantilist idea of promoting exports to promote growth. Buying foreign currencies to hold down domestic currencies so as to promote

exports is known as the mercantilist demand for reserves. Aizenman and Lee (2006 and 2005) provide extended discussions of the precautionary and mercantilist demands for reserves. Although both motives are likely to be in play in Asia, a systematic study of the relative importance of the two motives in Asia by Aizenman and Lee (2005) finds stronger empirical support for self-insurance motive. Related to the two main benefits but somewhat different is a third benefit from reserves—exchange rate stability. A central bank may accumulate reserves as a result of foreign exchange market interventions aimed at stabilizing the exchange rate.

Reserve accumulation not only yields benefits but entails costs as well. The three major costs of reserve accumulation are inflation, fiscal costs, and higher interest rate. A central bank's issuance of domestic currency to purchase foreign currency increases the monetary base, which in turn leads to inflation. In order to sterilize the inflationary impact of reserve accumulation, a central bank typically issues bonds, i.e., domestic liabilities, in exchange for currency in circulation, withdrawing domestic liquidity in the process. However, sterilization may entail a fiscal burden—the second major cost—if the interest rate a central bank pays on its outstanding bonds exceeds the interest rate it earns on its foreign reserve assets. The third major cost—higher interest rate—is also associated with sterilization. Sustained accumulation will eventually lead to a higher interest rate since there is a limit to the general public's appetite for sterilization bonds. Holding reserves entails some additional costs besides the three main costs.<sup>1</sup> According to Mohanty and Turner (2006), an unusually favorable constellation of factors, such as the benign global inflationary environment, have so far limited the costs of reserve accumulation in Asia.

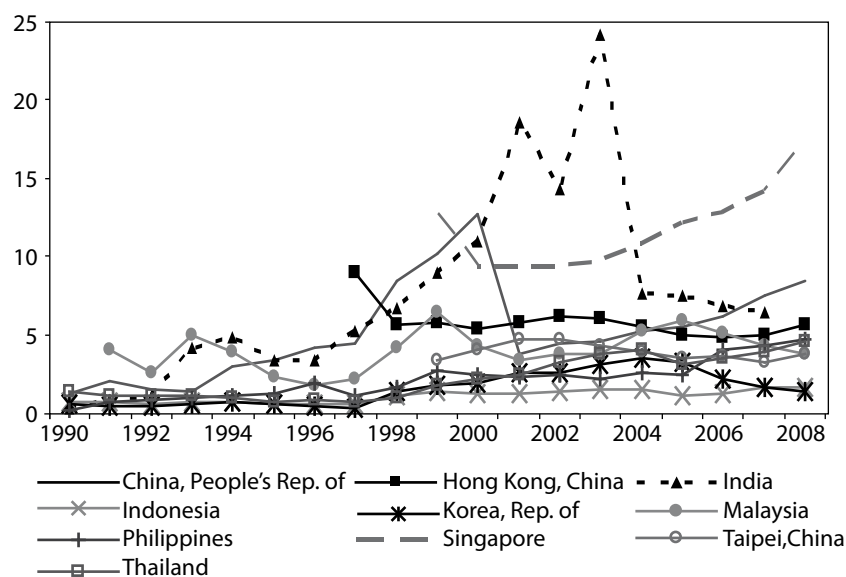
The optimal level of reserves is neither infinite since reserves entail costs, nor zero since reserves yield benefits. The optimal level of reserves is determined not by total benefits and costs of reserves but by their marginal benefits and costs. At least beyond a certain level, the marginal benefit of reserves is likely to diminish with the level of reserves. Intuitively, for example, an economy with US\$10 billion of external liabilities is unlikely to enjoy any positive benefit from its 200 billionth dollar of reserves. Likewise, beyond a certain level, the marginal cost of reserves is likely to increase with the level of reserves. Intuitively, for example, as the level of reserves approaches infinity, the massive growth of the monetary base will unleash inflationary pressures that would overwhelm any structural deterrents of inflation. There is a wide range of views about the costs and benefits of reserves and hence a lack of consensus about the optimal reserve level. In addition, the optimal reserve level differs from country to country and changes over time for a given country. There is no obvious reason why the benefits and costs of reserves should remain constant over time, especially in developing countries undergoing big structural changes such as capital account liberalization. The practical implication for Asian policymakers is that they should err on the side of caution in determining the optimal reserve level.

<sup>1</sup> These costs include balance sheet losses or valuation losses arising from the depreciation of the currency (e.g., US dollar) of the reserve assets and asset price inflation resulting from the increase in liquidity due incomplete sterilization. Rodrik (2006) identifies an interesting social cost of reserves, namely the government paying a higher interest rate on its external debt than it is earning on foreign assets held as reserves.

### III. Are Developing Asia's Reserves Excessive? An Informal Examination

In the preceding section, we discussed excess reserves from a conceptual or theoretical perspective. In this section, we report and discuss the results of some informal analyses of whether the region's reserves have indeed exceeded optimal levels. To gauge the magnitude of developing Asia's excess reserves, we now turn to some well-known measures of reserve adequacy.<sup>2</sup> Although these measures are informal rules of thumb based on general economic intuition rather than rigorously derived theoretical concepts, they perform quite well in empirical studies of reserve adequacy and thus provide useful guidance for policymakers. In particular, many such studies find one such rule of thumb (the ratio of reserves to short-term external debt) to be a significant determinant of an economy's vulnerability to financial crisis. More precisely, according to the so-called Greenspan-Guidotti rule, the critical value of this ratio is one, with a value above one signaling safety and a value below one signaling danger. The underlying idea here is that the country with reserves equal to or more than all external debt falling within one year should be able to service its immediate external obligations even during a financial crisis. Figure 4 clearly reveals that developing Asia comfortably passes the Greenspan-Guidotti test of reserve adequacy. The unmistakable implication is that the region has substantial amounts of excess reserves.

**Figure 4: Ratio of Foreign Exchange Reserves to Short-Term External Debt in Developing Asia's Top 10 Reserve Holders, 1990–2008**



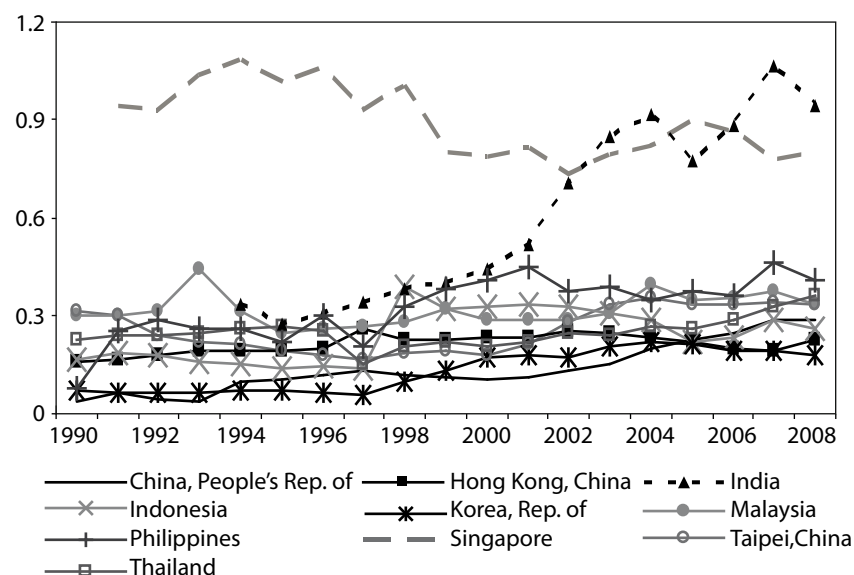
Sources: Authors' estimates based on data from CEIC Data Company Ltd.; Deutsche Bank Research, available: [www.dbresearch.de/servlet/reweb2.ReWEB?rwsite= DBR\\_INTERNET\\_EN-PROD](http://www.dbresearch.de/servlet/reweb2.ReWEB?rwsite= DBR_INTERNET_EN-PROD); International Monetary Fund, International Financial Statistics online database; and World Bank, Global Development Finance Online database, all downloaded 15 June 2009.

<sup>2</sup> Edison (2003), ECB (2006), and Green and Torgerson (2007) discuss the various reserve adequacy measures in detail.



Another well-known benchmark of reserve adequacy is the ratio of reserves to M2 or broad money. This ratio is especially relevant for countries at a significant risk of capital flight. The basic intuition is that the higher the ratio, the greater the confidence of the general public in the value of the local currency and hence the lower the likelihood of massive crisis-provoking flights into other currencies. Although there is no general consensus on the critical value of the reserves–M2 ratio, which is understandable given the inherent difficulty of measuring capital flight, the suggested values range from 5% to 20%. Figure 5 below shows that the reserves–M2 ratio falls comfortably within the range of 5–20% for the major reserve holders of developing Asia. In fact, the ratio is above 20%, in some cases far above 20%, for most of the countries in many years. Therefore, a look at the reserves–M2 ratio confirms that developing Asia’s reserve build-up may have resulted in substantial amounts of excess reserves.

**Figure 5: Ratio of Foreign Exchange Reserves to M2 in Developing Asia’s Top 10 Reserve Holders, 1990–2008**

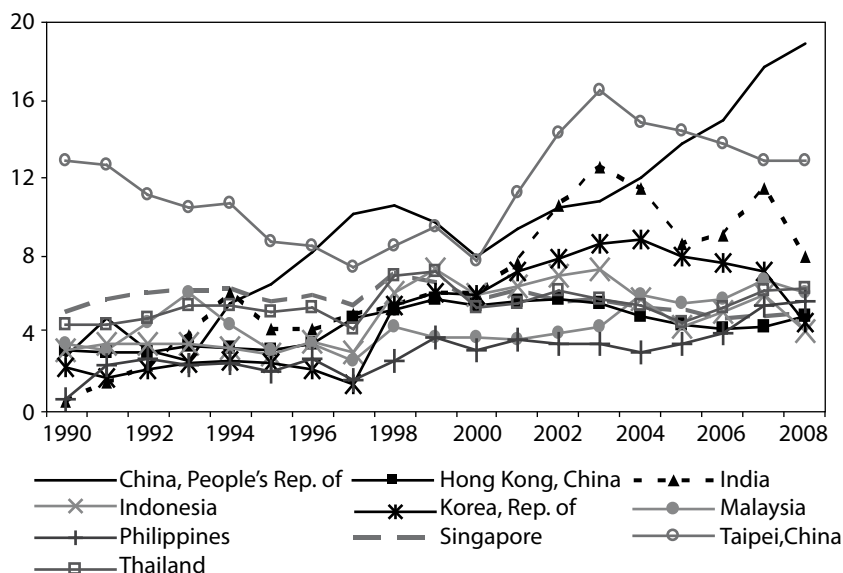


Sources: Authors’ estimates based on data from CEIC Data Company Ltd.; International Monetary Fund, International Financial Statistics online database; and World Bank, Global Development Finance Online database, all downloaded 15 June 2009.

The above two measures of reserve adequacy pertain to reducing an economy’s vulnerability to capital account shocks. Although financial globalization has pushed the capital account to the forefront and the current account to the backdrop in most discussions of reserve adequacy, one measure of adequacy pertaining to the current account, namely the months of imports that reserves can pay for, is still widely used. The basic idea is that a large stock of reserves will reduce the vulnerability of a country subject to adverse current account shocks and without significant access to international capital markets. There is general agreement that 3–4 months of imports is

the benchmark. Figure 6 shows that for most of developing Asia, the number of months that imports can cover is well above 4 months. Again, there are fairly strong grounds for suspecting a sizable gap between optimal and actual reserve levels.

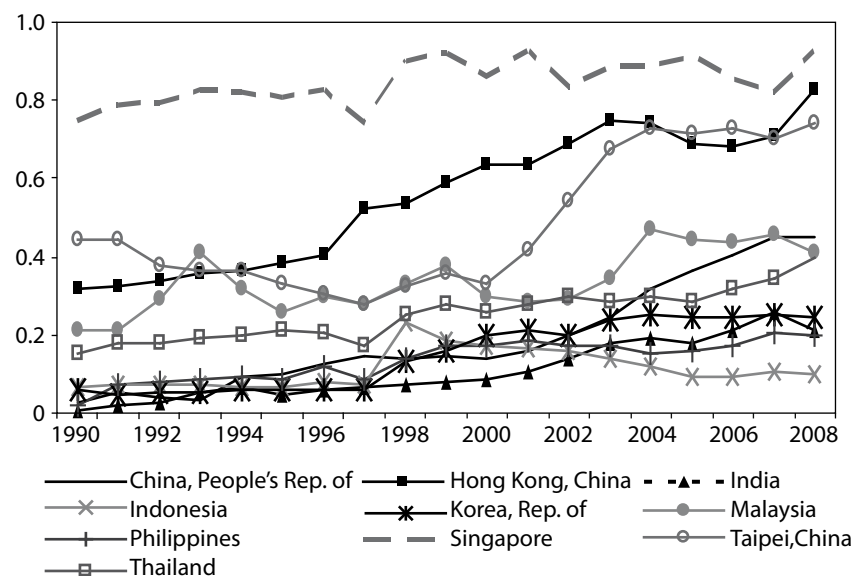
**Figure 6: Imports Covered by Foreign Exchange Reserves in Developing Asia's Top 10 Reserve Holders, 1990–2008 (number of months)**



Sources: Authors' estimates based on data from CEIC Data Company Ltd.; International Monetary Fund, International Financial Statistics online database; and World Bank, Global Development Finance online database, all downloaded 15 June 2009.

We examine one additional measure of reserve adequacy for which there is less theoretical or empirical justification than the three measures discussed above. Although GDP does not reflect an external vulnerability, it is nevertheless often used for scaling absolute reserve levels into relative terms. After all, it makes little sense to compare the total reserves of a US\$100 billion economy with those of a US\$10 billion economy. Furthermore, other things equal, a bigger economy will need more reserves than a smaller economy for the simple reason that it experiences larger amounts of international capital flows and trade. Figure 7 shows that the reserves–GDP ratio has been rising steadily throughout the region.

**Figure 7: Ratio of Foreign Exchange Reserves to GDP in Developing Asia's Top 10 Reserve Holders, 1990–2008**



Sources: Authors' estimates based on data from CEIC Data Company Ltd.; International Monetary Fund, International Financial Statistics online database; and World Bank, Global Development Finance online database, all downloaded 15 June 2009.

To summarize, informal tests based on widely used rules of thumb resoundingly confirm the conventional wisdom that developing Asia now has “too much” reserves. Whether we compare reserves to short-term external debt, broad measure of money supply, or the value of monthly imports, many countries in the region now apparently have more reserves than they need. This finding confirms the popular belief that the region may be better off shifting some reserves toward more active profit-seeking investments as opposed to traditional liquidity management.

## IV. Are Developing Asia's Reserves Excessive? An Econometric Examination

In the previous section, we saw that tests of reserve adequacy based on simple rules of thumb unambiguously indicate a substantial gap between actual reserves and optimal reserves. Indeed policymakers often rely on those simple rules instead of more rigorous econometric models to assess reserve adequacy. Nevertheless, it would be useful and interesting to apply such models to the issue of whether the region's reserves have become excessive. At a minimum, we would be able to compare the results of the informal adequacy tests with those of more formal econometric analysis. The alternative,

econometric approach to assessing reserve adequacy is to (i) estimate a model that relates reserve levels to various variables influencing reserves and (ii) compare actual reserve levels to reserve levels predicted by the model. We can interpret a positive gap between actual reserves and predicted reserves as evidence of excess reserves in the sense that reserves exceed those explained by fundamentals.

The theoretical and empirical literature exploring reserve adequacy more rigorously was very limited until recently when a growing number of studies attempted to formally model and empirically estimate optimal reserve levels. The recent growth of this literature has been motivated by the recent surge of reserves in developing countries in general and developing Asia in particular. Studies examining the region's optimal reserves include Wyplosz (2006); Jeanne and Ranciere (2006); Gosselin and Parent (2005); Mendoza (2004); Aizenman, Lee, and Rhee (2004); Aizenman and Marion (2004 and 2002); and Dooley, Folkerts-Landau, and Garber (2004). The overall balance of evidence in this emerging literature confirms the story told by the rules of thumb for reserve adequacy, that the region's current reserve build-up has overshoot its optimal level although the studies differ considerably about the extent of the overshooting. More precisely, the studies generally find the region's reserves beginning to exceed their optimal levels around 2001 or 2002. Another significant general finding is an apparent structural increase in optimal reserves in the post-1997 period, which is consistent with a stronger precautionary demand for reserves in the aftermath of the Asian crisis. This suggests that we should be cautious about reading too much into the growth in the absolute level of the region's reserves without due regard for changes in the fundamentals.

In this paper, we apply the empirical model in one such study (Edison 2003) to estimate developing Asia's optimal reserve levels during 1990–2007. Edison tries to explain reserves as a function of economic size, current account vulnerability, and exchange rate flexibility. Intuitively, since a country's international commercial transactions increase with its economic size, we can expect population and real GDP per capita to have a positive impact on reserves. Since vulnerability to external shocks increases with economic openness, we can expect trade openness to have a positive effect on reserve holdings. In particular, high dependence on imports will raise the demand for reserves. Larger external shocks (e.g., export volatility) will be associated with larger reserves. Greater exchange rate flexibility reduces the need for central banks to maintain a large stockpile of reserves with which to manage the exchange rate. In short, we expect reserves to have a positive relationship with population, real GDP per capita, imports–GDP ratio, and export volatility, and a negative relationship with exchange rate volatility.

Edison (2003) estimates her model using panel data for 122 emerging countries from 1980–1996. Controlling for fixed effects, the model is able to account for over 90% of the variation in reserve holdings. All five explanatory variables have the expected coefficient signs and all of them are significant except export volatility. Edison then uses the parameter estimates to generate out-of-sample forecasts and compares them with actual

reserve data for 1997–2002. Edison finds that while actual reserves were broadly in line with forecasts during 1997–2001, actual reserves exceeded forecasts after 2001. We re-estimate the model using panel data for 130 emerging economies from 1980 to 2004. Table 2 shows our estimation results, which indicate that the model can explain slightly over 90% of the demand for reserves. All the coefficients have the expected signs. Real per capita GDP, population, and exchange rate volatility are significant at the 1% level; imports-to-GDP ratio is significant at the 5% level; and export volatility is insignificant. Our estimation results are thus broadly similar with those of Edison.

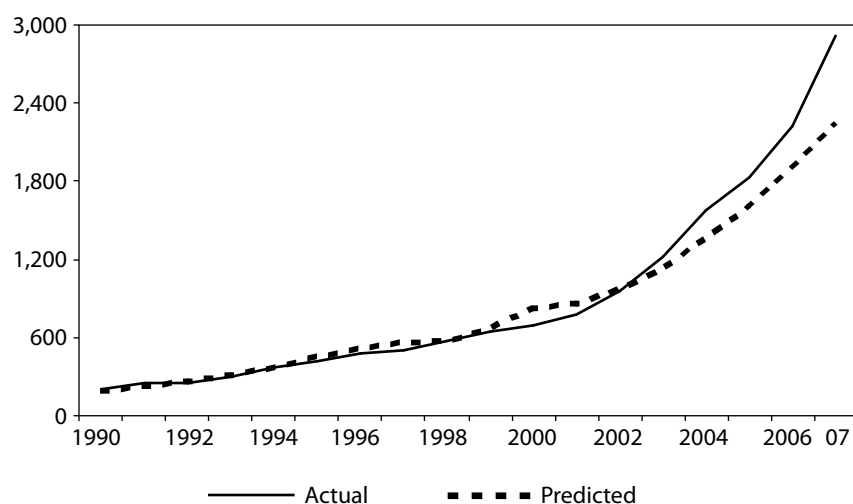
**Table 2: Multi-Variable Regression Results for Reserves**

Dependent Variable: Real Reserves	
Real GDP per capita	1.47 (6.78)**
Population	2.31 (5.30)**
Imports–GDP ratio	0.41 (2.53)*
Export volatility	0.06 (0.87)
Exchange rate volatility	–0.02 (–3.32)**
Number of observations	2,419
R-squared	0.92

\*\* denotes significance at 1% and \* denotes significance at 5%.

Note: Estimates are based on country fixed effects and a constant.  
Robust t-statistics are inside parentheses.

To estimate the size of developing Asia’s excess reserves, we compare the reserve levels predicted by the model with actual reserves. More precisely, we compare (i) the sum of the actual reserves of the top 10 regional reserve holders (see Table 1) and (ii) the sum of the predicted reserves of the same countries. For the period 2005–2007, we use our parameter estimates to generate out-of-sample forecasts. Figure 8 and Table 3 show trends in the region’s actual versus predicted reserves during 1990–2007. From 1990 to 2002, the region’s actual reserves either closely tracked or were lower than the reserves predicted by the model. Put differently, during this period, economic fundamentals could explain the bulk of developing Asia’s reserve accumulation. However, actual reserves begin to exceed predicted reserves from 2003 onward and the gap between the two grew over time until 2007. More specifically, the gap between the region’s actual and predicted reserves grew from US\$95 billion in 2003 to US\$228 billion in 2005 to US\$687 billion in 2007. The gap has grown not only in absolute terms but in relative terms as well, from 7.8% of actual reserves in 2003 to 12.5% in 2005 to 23.6% in 2007.

**Figure 8: Actual versus Predicted Reserves of Developing Asia, 1990–2007 (billion US\$)**

Source: Authors' estimates.

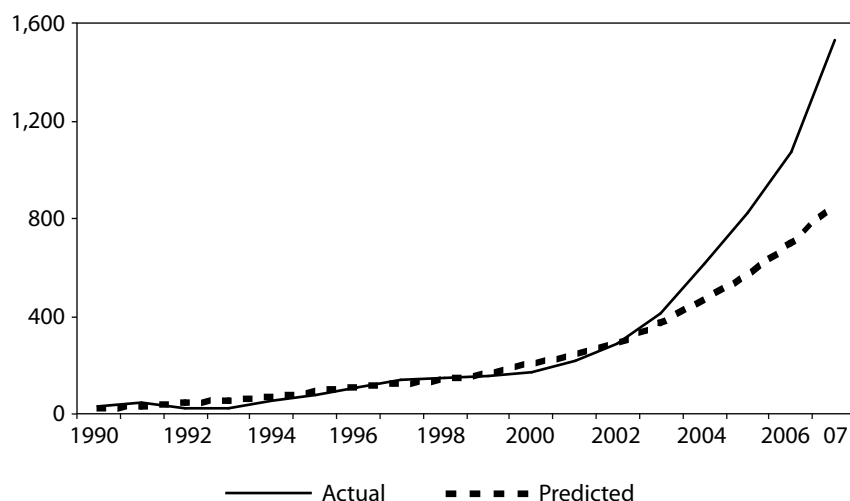
**Table 3: Actual versus Predicted Nominal Reserves of Developing Asia, 1990–2007 (billion US\$)**

Year	Actual	Predicted
1990	202.14	187.59
1991	247.31	223.95
1992	253.36	263.48
1993	295.45	312.38
1994	371.18	366.86
1995	420.36	450.85
1996	483.11	513.03
1997	506.37	564.09
1998	569.94	571.68
1999	648.23	671.65
2000	698.70	819.78
2001	775.87	854.95
2002	951.62	964.84
2003	1,217.13	1,122.54
2004	1,580.56	1,363.65
2005	1,827.08	1,599.61
2006	2,222.24	1,900.56
2007	2,916.75	2,229.78

Sources: CEIC Data Company Ltd.; International Monetary Fund, International Financial Statistics online database, both downloaded 15 June 2009; authors' estimates.

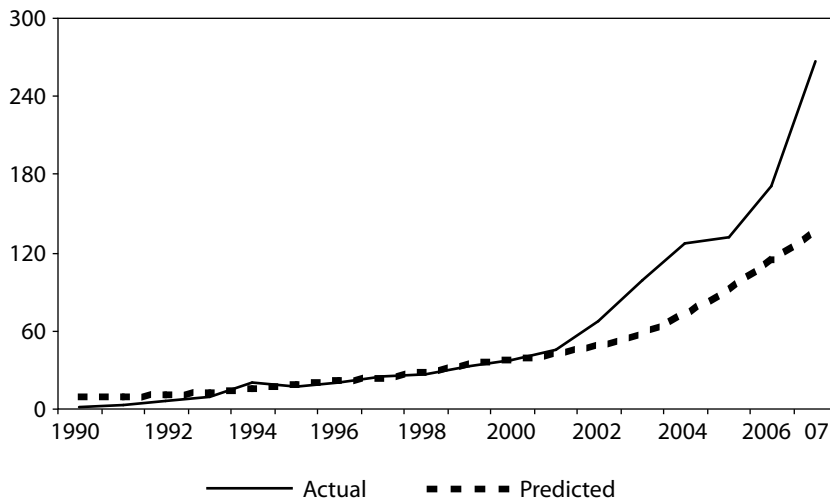
Although the gap between actual reserves and predicted reserves has grown for developing Asia as a whole since 2003, there are substantial differences across countries. We also used Edison’s model to estimate excess reserves for each of the top 10 reserve holders. According to our estimates, PRC, India, and Korea jointly accounted for the lion’s share of growth in the region’s excess reserves during 2003–2007. Our estimates also indicate that different countries experienced a surge in excess reserves at different points in time. Figure 9 below shows trends in the PRC’s actual versus predicted reserves during 1990–2007. The gap between the PRC’s actual reserves and predicted reserves broadly mirrors the gap for the region as a whole. Until 2001, economic fundamentals could explain most of the growth in the PRC’s reserves. However, from 2002 onward, actual reserves began to exceed predicted reserves by a large and growing margin. Figures 10 and 11 below show the trends in the actual reserves versus predicted reserves for India and Korea, respectively. For both countries, the movement of the actual-predicted gap is broadly similar to the actual-predicted for developing Asia as a whole, i.e., small or no gap during the early part of 1990–2007 followed by the emergence of a more visible gap in the later part. In the case of Korea, one of the hardest-hit economies during the Asian crisis, excess reserves began to emerge in 1998, in the immediate aftermath of the Asian crisis.

**Figure 9: Actual Versus Predicted Reserves of the People’s Republic of China, 1990–2007 (billion US\$)**



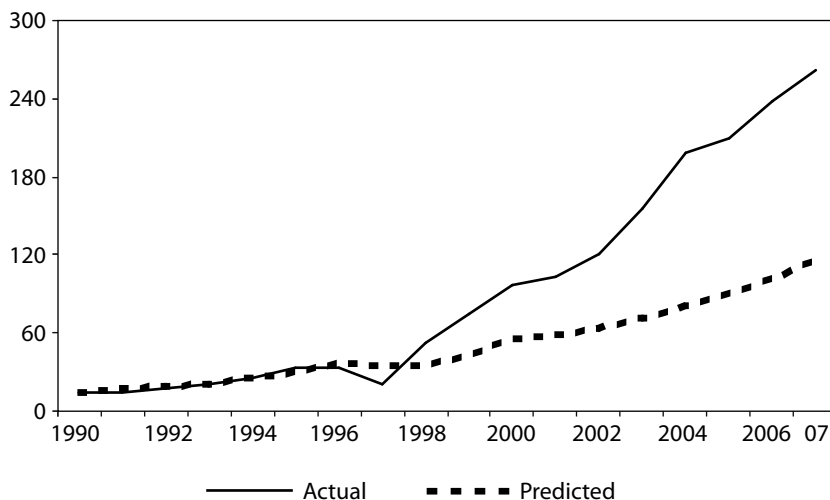
Source: Authors’ estimates.

**Figure 10: Actual Versus Predicted Reserves of India, 1990–2007**



Source: Authors' estimates.

**Figure 11: Actual Versus Predicted Reserves of Korea, 1990–2007 (billion US\$)**



Source: Authors' estimates.

In summary, the evidence from our panel-data econometric analysis based on Edison (2003) indicates that the region's actual reserve levels are now substantially above the reserve levels that can be attributed to economic fundamentals. While there are significant differences across countries in the size and timing of excess reserves, the overall pattern is one of large and growing excess reserves during the later part of our sample period, especially since 2003. Therefore, our econometric regression results



are consistent with the results of informal reserve adequacy tests. It should be noted that rapid growth of actual reserves does not necessarily imply rapid growth of excess reserves since optimal reserves may also grow rapidly over time. Finally, we do not purport our estimates of excess reserves to be authoritative or definitive since they are based on one particular empirical model of reserves. Nevertheless, our study is consistent with the broad thrust of the empirical literature in that we find strong evidence of excess reserves.

## V. Concluding Observations

The scale and speed of developing Asia's reserve build-up since the Asian crisis has been unprecedented. The build-up may have been initially motivated by precautionary self-insurance purposes, in particular a regionwide desire to avoid a repeat of the Asian crisis, which has left an indelible scar on the region's collective psyche. Nevertheless, there is a growing consensus that the region's reserves now exceed all plausible estimates of what the region needs for traditional purposes. This brings up the important question posed in the title of this paper, of whether developing Asia's foreign exchange reserves have in fact reached excessive levels. Both the informal and formal analysis in this paper suggests that the answer to the question is a loud and clear yes. Applying informal tests of reserve adequacy such as the Greenspan-Guidotti rule suggests that the region now has substantially more than adequate reserves. Furthermore, comparing the region's actual reserves with the reserves predicted by an econometric model that explains reserves with a number of economic variables also yields the same conclusion.

The presence of large and growing excess reserves suggests that the region would be better off investing those reserves more actively to maximize risk-adjusted returns. The alternative of continuing to use excess reserves to purchase safe and liquid but low-yielding traditional reserve assets is indeed a costly waste of valuable resources. Therefore, the widespread notion that developing Asia should manage at least some of its growing stockpile of reserves more actively is not only politically popular but economically sound. Nevertheless, shifting part of reserves from passive liquidity management to active profit-seeking investment, although attractive in principle, will not be easy to put into practice. Investing in high-risk, high-yield assets such as equities rather than low-risk, low-yield assets such as US government bonds may entail heavy losses in the absence of adequate risk management capacity. Excess reserves are a relatively new phenomenon in developing Asia and the region's governments have only limited capacity and experience in actively investing reserves to maximize profits as opposed to managing them for traditional liquidity purposes. More generally, there are a large number of difficult specific challenges arising from more active management of the region's reserves, as discussed extensively in Park (2007).

The Korean experience during the global financial crisis highlights the limitations of our research. Despite having one of the world's largest stocks of FX reserves and comfortably passing all conventional tests of reserve adequacy, both the Korean currency and stock market came under severe attack during the third quarter of 2008, triggering widespread fears about a repeat of the 1997–1998 crisis. The currency and stock market began to stabilize only after the Bank of Korea entered into a swap agreement with the US Federal Reserve. Both the real economy and financial system have since recovered and, in fact, Korea is currently enjoying one of the fastest and strongest recoveries in the region. The lesson from the Korean experience is not that conventional measures of reserve adequacy are completely useless guides for policymakers. The global financial crisis is an unprecedented, extraordinary shock so it would not make sense to make generalizations such as “more reserves is always better than less” on the basis of the crisis. However, the Korean experience does point to the need to develop a more nuanced approach for measuring reserve adequacy, perhaps a more contingency-based approach that takes into account the possibility of severe negative shocks in gauging adequacy. Developing such measures represents a promising and policy-relevant agenda for future research on reserves and reserve accumulation.

The global financial crisis also serves as a sobering warning to Asian policymakers about the very real risks involved in shifting from a conservative investment strategy to a more aggressive investment strategy within the context of excess reserve management. Asian sovereign wealth funds are known to have suffered heavy paper losses on their investments in western financial institutions as their market values cratered during the peak of the crisis. However, those losses have receded more recently as the market values have recovered along with the stabilization of western financial systems and the incipient recovery of the world economy. Again, we should refrain from making generalizations on the basis of an unprecedented, extraordinary shock and suggesting that Asian countries should invest their excess reserves solely in traditional reserve assets. Nevertheless, the global crisis does highlight the need for Asian countries to manage their excess reserves more actively only after they have acquired sufficient institutional capacity to do so. In shifting from passive liquidity management to active profit-seeking investment, a gradualist approach of learning-by-doing is likely to be more effective than a cold-turkey approach of plunging full-steam into the often turbulent waters of global financial markets.

Finally, if we take a more long-term view, the issue of what to do with excess reserves once they have already been accumulated is a study of the “second best.” The obvious “first-best” solution (to the problem of too many reserves) is not to accumulate them in the first place. But slowing or reversing reserve accumulation may not be easy. Even sharp appreciations of some regional currencies, such as the Korean won, have not slowed the pace of accumulation. Ultimately, the root cause of excess reserve accumulation lies in the combination of excess net saving (the difference between domestic saving and domestic investment) and the inability of capital markets to intermediate surpluses

efficiently. Tackling the underlying structural problems from which excess reserves emerge is difficult, and likely to take time. For example, expanding access to pensions and health insurance would require concerted government efforts. In addition to these steps, governments could consider liberalizing capital outflows so that the private sector plays a bigger role in the export of capital from the region to the rest of the world.

## References

- Aizenman, J., and J. Lee. 2005. International Reserves: Precautionary versus Mercantilist Views, Theory and Evidence. IMF Working Paper 05/198, International Monetary Fund, Washington, DC.
- \_\_\_\_\_. 2006. Financial versus Monetary Mercantilism: Long-run View of Large International Reserves Hoarding. IMF Working Paper 06/280, International Monetary Fund, Washington, DC.
- Aizenman, J., and N. Marion. 2002. "The High Demand for International Reserves in the Far East: What's Going On?" *Journal of the Japanese and International Economies* 17(3):370–400.
- \_\_\_\_\_. 2004. "International Reserve Holdings with Sovereign Risk and Costly Tax Collection." *Economic Journal* 114(497):569–91.
- Aizenman, J., J. Lee, and Y. Rhee. 2004. International Reserves Management and Capital Mobility: Policy Considerations and a Case Study of Korea. NBER Working Paper No. 10534, National Bureau of Economic Research, Massachusetts.
- Dooley, M., D. Folkerts-Landau, and P. Garber. 2004. "The Revived Bretton Woods System." *International Journal of Finance and Economics* 9(4):307–13.
- Edison, H. 2003. "Are Foreign Reserves in Asia too High?" In *World Economic Outlook 2003 Update*. International Monetary Fund, Washington, DC.
- European Central Bank. 2006. The Accumulation of Reserves. ECB Occasional Paper No. 43, Frankfurt.
- Gosselin, M., and N. Parent. 2005. An Empirical Analysis of Foreign Exchange Reserves in Emerging Asia. Bank of Canada Working Paper 2005-38, Ontario.
- Green, R., and T. Torgerson. 2007. Are High Foreign Exchange Reserves in Emerging Markets a Blessing or a Burden? US Department of the Treasury Occasional Paper No. 6, Washington, DC.
- Jeanne, O., and R. Ranciere. 2006. The Optimal Level of International Reserves for Emerging Market Economies: Formulas and Applications. IMF Working Paper 06/229, International Monetary Fund, Washington, DC.
- Mendoza, R. 2004. "International Reserve-holding in the Developing World: Self-insurance in a Crisis-prone Era?" *Emerging Markets Review* 5(1):61–82.
- Mohanty, M. S., and P. Turner. 2006. "Foreign Exchange Reserve Accumulation in Emerging Markets: What are the Domestic Implications?" *BIS Quarterly Review* September:39-52.
- Park, D. 2007. Beyond Liquidity: New Uses for Developing Asia's Foreign Exchange Reserves. ADB Economics Working Paper No. 109, Economics and Research Department, Asian Development Bank, Manila.
- Rodrik, D. 2006. The Social Cost of Foreign Exchange Reserves. NBER Working Paper 11952, National Bureau of Economic Research, Massachusetts.
- Wyplosz, C. 2006. "The Foreign Exchange Reserves Buildup: Business as Usual?" Graduate Institute of International Studies and CEPR. Available: [www.un.org/esa/ffd/events/2007debtworkshop/Wyplosz.pdf](http://www.un.org/esa/ffd/events/2007debtworkshop/Wyplosz.pdf).

## **About the Paper**

Donghyun Park and Gemma Estrada use both informal rules of thumb and formal econometric analysis to test whether developing Asia has surplus foreign exchange reserves. They find that the region now has substantial surplus reserves due to a rapid build-up of reserves since the Asian crisis. Therefore, a key short-run policy challenge confronting Asian countries is to use their surplus reserves more productively.

## **About the Asian Development Bank**

ADB's vision is an Asia and Pacific region free of poverty. Its mission is to help its developing member countries substantially reduce poverty and improve the quality of life of their people. Despite the region's many successes, it remains home to two thirds of the world's poor: 1.8 billion people who live on less than \$2 a day, with 903 million struggling on less than \$1.25 a day. ADB is committed to reducing poverty through inclusive economic growth, environmentally sustainable growth, and regional integration.

Based in Manila, ADB is owned by 67 members, including 48 from the region. Its main instruments for helping its developing member countries are policy dialogue, loans, equity investments, guarantees, grants, and technical assistance.